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Parasitic and phoretic mites of Diptera in Israel and the Sinai Peninsula, Egypt

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ABSTRACT

Certain mites (Acarina) are parasitic on insects and other arthropods or use them as a means for transport to habitats where they find more suitable environmental conditions. This article reports on phoretic and parasitic mites collected from Diptera in Israel and Egypt. Flies from the families Muscidae, Ceratopogonidae, Sphaeroceridae, Milichiidae, Sepsidae, and Ulidiidae were collected in the periphery of cowsheds and horse stables using Williams fiberglass panel (Alsynite), Monks Wood, and DuToit suction traps. Specimens of the housefly (*Musca domestica*) and of the stable fly (*Stomoxys calcitrans*) were infested mainly by *Macrocheles muscaedomesticae*, and to a lesser extent, by *Macrocheles subbadius*, trombiculid larvae, and *Dendrolaelaps* nymphs. Most *Culicoides* species (Ceratopogonidae) were infested by watermite larvae of the families Limnesiidae, Thyasidae, and Arrenuridae, as well as by larvae of the terrestrial Trombidiidae and Neotrombidiidae, whereas representatives of the remaining dipteran families were infested mainly by astigmatid, prostigmatid, and mesostigmatid mites.

KEYWORDS: Acari, mite, insect, parasite, phoresis, Diptera, Israel

INTRODUCTION

Mites are known to parasitize vertebrates as well as insects and other arthropods. The larvae of several species of water mites are ectoparasites of adult mosquitoes and midges, the majority of which belong to the genera *Thyas* (Thyasidae) and *Arrenurus* (Arrenuridae). Mullen (1975) gathered 238 worldwide records of acarine parasites of mosquitoes that were always attached to membranous areas of the host body. In this article, we report on the groups of mites that were found to be phoretic or parasitic on Diptera in Israel.

Phoresis is a phenomenon by which a migrating animal (the phoretic stage) actively seeks, and attaches to, the surface of another animal and thus is transported to other habitats of more favorable environmental conditions. After migration, pending suitable

conditions, the phoretics leave the carrier to colonize a new habitat. For mites, especially those with restricted environmental tolerance, dispersal is vital. Due to their size and limited mobility, they often depend on other animals, particularly arthropods, for dispersal (Kaliszewski et al., 1995).

Acari exhibit four main types of phoresy: A) certain adult females attach to a carrier by means of chelicerae, palpal hooks, legs, and/or ambulacral claws, usually grasping a seta or a fold of the integument of the carrier; B) some deutonymphs attach to the host with their ambulacral claws; C) other deutonymphs attach to the host by means of an anal pedicel formed by a substance extruded from the anus that hardens upon contact with air and literally glues the mite to its host; and D) certain deutonymphs (i.e., the stage called hypopus that develops between the protonymph and tritonymph stages when environmental conditions are no longer appropriate for mite development and is specific to mites of the suborder Astigmata) attach themselves with sucker-like discs or claspers and are transported to areas where they develop into tritonymphs (Hughes, 1961; Mitchell, 1970). Recognition of the ideal host is vital for transportation to a new site, and is often based on chemical or olfactory stimuli produced by the host. *Macrocheles muscaedomesticae* (Scopoli) (Macrochelidae) is attracted to its host (beetles or houseflies) by water-soluble compounds that are produced or accumulated by the host on its cuticle (Hunter and Rosario, 1988).

In the present study, a large number of flies was collected within the context of two different projects: A) monitoring the introduction of Rift Valley fever into the Sinai by *Culicoides sp*. (Ceratopogonidae), and B) testing Williams traps that are based on glue-coated Alsinite panels as a new means for the control of houseflies, stable flies, and other muscoids near animal houses. During the identification of the flies, we noticed that many of them had mites attached to their bodies. Thus, the aim of this study was to report on the groups of mites that were found to be phoretic or parasitic on Diptera in Israel and Egypt and to investigate whether the relevant insects serve as a vehicle for mites of veterinary and/or medical importance.

MATERIALS AND METHODS

Culicoides (Ceratopogonidae) specimens collected in oases across the Sinai Peninsula were trapped by portable Monks Wood suction traps fitted with black light tubes, whereas in ‘Iddan (the Arava Valley, Israel), these insects were collected around a cowshed using DuToit suction black-light trap (DuToit, 1944). The other dipterans were collected in Bet Dagan, Einat, Qiryat Anavim, Akko, and Kabri in Israel, in the periphery of cowsheds and horse stables using Williams traps (Williams, 1973).

Specimens of *Culicoides, Musca domestica* L., and *Stomoxys calcitrans* L. were identified by one of the authors (YB); the remaining Diptera by Dr. Amnon Freidberg (Department of Zoology, Tel Aviv University). The *Culicoides* collection was deposited in the National Collection of Insects, Tel Aviv University. Mites were removed from the insects under stereomicroscope and preserved in 70% ethyl alcohol. They were then cleared in Hoyer’s solution and mounted on permanent microscopic slides for identi-

fication under a light microscope (× 40–100). Mite specimens isolated from Muscidae were deposited in the laboratory of Dr. A. Fain (Antwerp, Belgium) and those from the remaining fly species are in the collection of Dr. G.R. Mullen (Auburn, AL, USA).

RESULTS AND DISCUSSION

The insects collected in this study, together with their phoretic and/or parasitic mites, were subdivided into three groups, i.e., Muscidae, Ceratopogonidae, and other dipterans (Tables 1–3).

Mites on Muscidae

Most houseflies (*M. domestica* L.) and stable flies (*S. calcitrans* L.) were infested by the mesostigmatid mite *Macrocheles muscaedomesticae* (Macrochelidae), and a smaller number were infested by nymphs of *M. subbadius* Berlese and *Dendrolaelaps* sp. (Digamasellidae), as well as by trombiculid larvae (Trombiculidae) (Table 1). The Macrochelidae is a cosmopolitan family of predatory mesostigmatic mites, many of which occupy specialized and often unstable habitats. Most known species have adapted to life in dung, and phoresis on co-occurring flying insects plays a vital role in assuring niche continuity for macrochelids in these substrates (Krantz, 1962; 1998). The phoretic association between *M. muscaedomesticae* and flies that inhabit poultry manure was studied thoroughly in Malaysia, and representatives of ten families of mites were found on *M. domestica,* the most common of which being *M. muscaedomesticae* (Ho, 1990). In Israel, *M. muscaedomesticae* was found in manure heaps and phoretic on *M. domestica* and other flies (Costa 1966).

Mites on Ceratopogonidae

In the present study, most *Culicoides* species were infested by water-mite larvae of the families Limnesiidae, Thyasidae, and Arrenuridae, as well as by larvae of the terrestrial Trombidiidae and Neotrombidiidae (Table 2). Larvae of water mites (Hydrachnidae) from the above-mentioned families are known ectoparasites of insects in freshwater ecosystems (Mullen, 1977; Smith and Oliver, 1986; Smith, 1988). The larval stage of the trombidioid mites, *Parafeiderium stuarti* Baker (Microtrombidiidae) and *Centrotrombidium blackwellae* Baker (Johnstonianidae), were found to parasitize *Culicoides impunctatus* Goetghebuer in Scotland (Baker, 1999). Reduced survivorship of insects parasitized by these mites was also observed in other Ceratopogonidae (Lanciani, 1986).

Phoretic mesostigmatid mites, such as *Trachygamasus ambulacralis* (Willmann) that is usually found in humid and water-logged habitats, and *Iphidozercon gibbus* Berlese that is often found in soil, compost, and forest litter, were found on *Culicoides obsoletus* (Meigen) (Masan and Orszagh, 1994). Mesostigmatid mites of the families Eugamasidae and Ascidae were found phoretic on biting midges also in Siberia (Nikolskii et al., 1981) and North America (Grogan, 1977), and mites parasitizing Ceratopogonid flies were described by Wirth (1977), Lanciani (1978), Fain and Domrow (1980), and

Table 1
Phoretic and parasitic mites found on members of the family Muscidae in Israel

Insect host	Locality	Date	Phoretic/parasitic mite	Taxonomic position	Mite identification
Musca domestica	Bet Dagan	11.04.78	Trombidiid larva	Trombidiidae Prostigmata	AF*
Musca domestica	Bet Dagan	11.04.78	*Dendrolaelaps* spp., Nymph 2	Digamasellidae Mesostigmata	AF
Musca domestica	Bet Dagan	27.03.79	*Macrocheles muscaedomesticae*	Macrochelidae Mesostigmata	AF
Musca domestica	Qiryat Anavim	10.08.79	Trombidiid larva	Trombiculidae Prostigmata	AF
Musca domestica	Einat	03.09.79	*Macrocheles muscaedomesticae,* Female	Macrochelidae Mesostigmata	AF
Musca domestica	Bet Dagan	28.03.78	*Dendrolaelaps* spp., Nymph 2	Digamasellidae Mesostigmata	GRM**
Musca domestica	Bet Dagan	02.01.80	*Macrocheles muscaedomesticae,* Female	Macrochelidae Mesostigmata	AF
Stomoxys calcitrans	Bet Dagan	12.03.80	*Macrocheles muscaedomesticae,* Female	Macrochelidae Mesostigmata	AF
Stomoxys calcitrans	Bet Dagan	29.10.86	*Macrocheles subbadius,* Female	Macrochelidae Mesostigmata	GRM
Stomoxys calcitrans	Bet Dagan	29.10.86	*Macrocheles subbadius,* Female	Macrochelidae Mesostigmata	GRM
Stomoxys calcitrans	Bet Dagan	30.06.86	*Macrocheles muscaedomesticae,* Female	Macrochelidae Mesostigmata	GRM
Stomoxys calcitrans	Bet Dagan	30.06.86	*Macrocheles muscaedomesticae,* Female	Macrochelidae Mesostigmata	GRM
Atherigona spp.	Bet Dagan	25.12.78	Uropodinae, Nymph II	Uropodidae Mesostigmata	GRM

*AF = Alex Fain
**GRM = Gary R. Mullen

Table 2

Phoretic and parasitic mites found on *Culicoides* species (Ceratopogonidae) collected in the Sinai Peninsula, Egypt, and the Arava Valley, Israel

Insect host	Locality	Date	Phoretic/parasitic mite	Taxonomic position	Mite Identification
Culicoides calloti	Saidna Mussa	06.06.79	Limnesiidae, Larva	Prostigmata	GRM*
Culicoides lailae	'Iddan**	22.01.80	Limnesiidae, Larva	Prostigmata	GRM
Culicoides langeroni	Saidna Mussa	07.06.79	Thyasidae, Larva	Prostigmata	GRM
Culicoides firuzae	Wadi baabaa	09.06.79	Thyasidae, Larva	Prostigmata	GRM
Culicoides sejfadinei	Wadi saal	16.10.79	Limnesiidae, Larva	Prostigmata	GRM
Culicoides sejfadinei	Wadi saal	16.10.79	*Arrenurus* spp., Larva	Arrenuridae, Prostigmata	GRM
Culicoides zerbajdzhanicus	Wadi baabaa	09.06.79	Trombidiidae, Larva	Prostigmata	GRM
Culicoides azerbajdzhanicus	Wadi baabaa	09.06.79	*Neotrombidium* spp., Larva	Neotrombidiidae, Prostigmata	GRM
Culicoides mosulensis	Wadi baabaa	09.06.79	Thyasidae, Larva	Prostigmata	GRM
Culicoides sejfadinei	Wadi saal	16.10.79	*Arrenurus* spp., Larva	Arrenuridae, Prostigmata	GRM
Culicoides spp.	Wadi saal	16.10.79	Limnesiidae, Larva	Prostigmata	GRM
Culicoides spp.	Wadi saal	16.10.79	Limnesiidae, Larva	Prostigmata	GRM
Culicoides spp.	Wadi saal	16.10.79	Limnesidae, Larva	Prostigmata	GRM
Culicoides spp.	Wadi saal	16.10.79	Limnesiidae, Larva	Prostigmata	GRM

*GRM = Gary R. Mullen

**Israel

Table 3
Phoretic and parasitic mites found on Diptera other than Muscidae in Israel****

Insect host	Locality	Date	Phoretic/parasitic mite	Taxonomic position	Mite identification
Coprophila vagans			- *Pediculaster mesembrinae,* Female	Pyemotidae, Prostigmata	
(Sphaeroceridae)	Bet Dagan	02.01.80	- Phytoseiidae, Nymphs	Phytoseiidae, Mesostigmata	AF*
Coprophila vagans					
(Sphaeroceridae)	Bet Dagan	16.01.80	Phytoseiidae, Nymphs	Phytoseiidae, Mesostigmata	AF
Coprophila sp.			- *Pediculaster mesembrinae,* Female	Pyemotidae, Prostigmata	
(Sphaeroceridae)	Bet Dagan	02.01.80	- Phytoseidae, Nymphs	Phytoseiidae, Mesostigmata	AF
Desmometopa m-nigrum					
(Milichiidae)	Bet Dagan	02.01.80	Phytoseidae, Nymphs	Phytoseiidae, Mesostigmata	AF
Desmometopa m-nigrum					
(Milichiidae)	Bet Dagan	16.01.80	Phytoseiidae, Nymphs	Phytoseiidae, Mesostigmata	AF
Sepsis spp.					
(Sepsidae)	Akko	08.01.80	*Macrocheles muscaedomesticae,* Female	Macrochelidae, Mesostigmata	AF
Physiphora demandata					
(Ulidiidae)	Bet Dagan	11.04.78	Phytoseiidae, Nymphs	Phytoseiidae, Mesostigmata	AF
(Ulidiidae)	Bet Dagan	28.03.78	*Dendrolaelaps* spp., Nymph II	Digamasellidae, Mesostigmata	GRM**
(Ulidiidae)	Bet Dagan	28.03.78	*Histiostoma* spp., Hypopus	Anoetidae, Astigmata	KYM***
Diptera	Kabri	15.01.80	*Parasitus fimetorum* (Berl), Nymph	Parasitidae, Mesostigmata	GRM
Diptera	Kabri	15.01.80	Tyrophagus spp., 2 females	Acaridae, Astigmata	KYM

*AF = Alex Fain
**GRM = Gary R. Mullen
***KYM = Kosta Y. Mumcuoglu
****Identified by Amnon Freidberg

Fain and Kratz (1990). The breeding sites of many *Culicoides* spp. are scarcely known. While hatching from pupae to adults and during oviposition, these biting midges might be infested by phoretic and/or parasitic mites found in their breeding sites. Thus, the presence of a specific mite on a biting midge may be indicative of the breeding site of the *Culicoides* species carrying it.

Mites on other Diptera families

The remaining dipteran families found in the present study were infested mainly by prostigmatid, mesostigmatid, and astigmatid mites (Table 3). Females of the prostigmatid *Pediculaster mesembrinae* (Canestrini) (Pygmephoridae) were previously found to be phoretic on insects (Camerik et al., 2006). Mites of the families Pyemotidae and Pygmephoridae are often transported by insects, including flies. Dimorphic females within these families have been described, and those which are morphologically adapted for phoresy are known as phoretomorphs (Moser and Cross, 1975). In the present study, phytoseid mites (Phytoseidae, Mesostigmata) were found on diverse fly species, including *Coprophila vagans* Spuler and *Coprophila* sp. (Sphaeroceridae), *Desmometopa m-nigrum* (Zetterstedt) (Milichiidae), as well as on representatives of other families, such as Ulidiidae. Phytoseid mites are predators of other mites and insects. *Phytoseiulus persimilis* (Athias-Henriot) is being used to control the two-spotted spider mite, *Tetranychus urticae* (Koch) (Campbell and Lilley, 1999). In the present study, *Parasitus fimetorum* (Berlese) was found on an unidentified fly from Kabri; this species was previously recorded in Israel from the dung beetle *Copris hispanus* (L.), manure heaps, and decaying vegetation, as well as from the nest of the Levant vole (*Microtus guentheri*) (Costa, 1966).

Under unfavorable environmental conditions, representatives of the Anoetidae (Astigmata) such as *Histiostoma*, produce hypopodes nymphs, which do not feed at all in this developmental stage and are associated with other animals. Chmielewski (2009) found that approximately 80% of the earwigs (*Forficula* spp.) collected in beehives were infested by hypopodes of *Histiostoma polypori* (Oudemans) and *Histiostoma feroniarum* (Dufour). The two female specimens belonging to *Tyrophagus* sp. (Astigmata) found on an unidentified fly from Kabri, most probably represent an accidental contamination. To the best of our knowledge, the representatives of this species do not produce hypopodes and the adults are free-living, largely mycetophagous mites.

In conclusion, two of the mites we found, *P. mesembrinae* and *M. subbadius*, are, to the best of our knowledge, new for the Israeli mite fauna. None of the mites reported here is known to have any medical or veterinary importance.

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